

The Immature Stages of the Genus *Lipsothrix* in the Western United States

(Tipulidae : Diptera)

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There are five species of the genus *Lipsothrix* presently known to occur in America north of Mexico. The habitats of the four species described in this paper, *Lipsothrix shasta*, *L. nigrilinea*, *L. hynesiana*, and *L. fenderi*, are quite similar to that described by Rogers and Byers (1956) for *L. sylvia*, the single species found in the eastern United States. There appear to be no striking differences among the species in habitat preference in so far as type or condition of wood and size of stream. In fact, *L. nigrilinea* and *L. fenderi* have been collected side by side in the same log or branch.

The larvae of *L. hynesiana* have been observed to form burrows in the wood along which are found feeding chambers. The larvae position themselves in these chambers with the body bent back in such a manner that the head lies just beyond the spiracular disk. These chambers become packed with fecal pellets, and the chambers are continually enlarged as the larvae feed. It is apparent that as the larvae mature they tend to remain in the feeding chamber, leaving just prior to pupation to take a position just beneath the outer surface of the log or branch. Another observation of this species, and one which must eventually be considered by those who might work on the habitat restrictions of species within this genus, is that the eggs have a very thin and delicate chorion and will often burst when placed in water, even that from the microhabitat. This indicates an extreme sensitivity to solute concentrations in the water and may explain why the immature stages of all species have not been found in conditions other than those described by Rogers for *L. sylvia*.

Lipsothrix hynesiana emerges primarily during the period extending from November through March, with the peak emergence around December and January. *Lipsothrix shasta* emerges during the months of June and July, but judging from observations on the size of the larvae in the habitats almost certainly continues emerging for the remainder of the summer. Little information concerning seasonal emergence has been gathered for *L. fenderi* and *L. nigrilinea*, but the specimens reared in

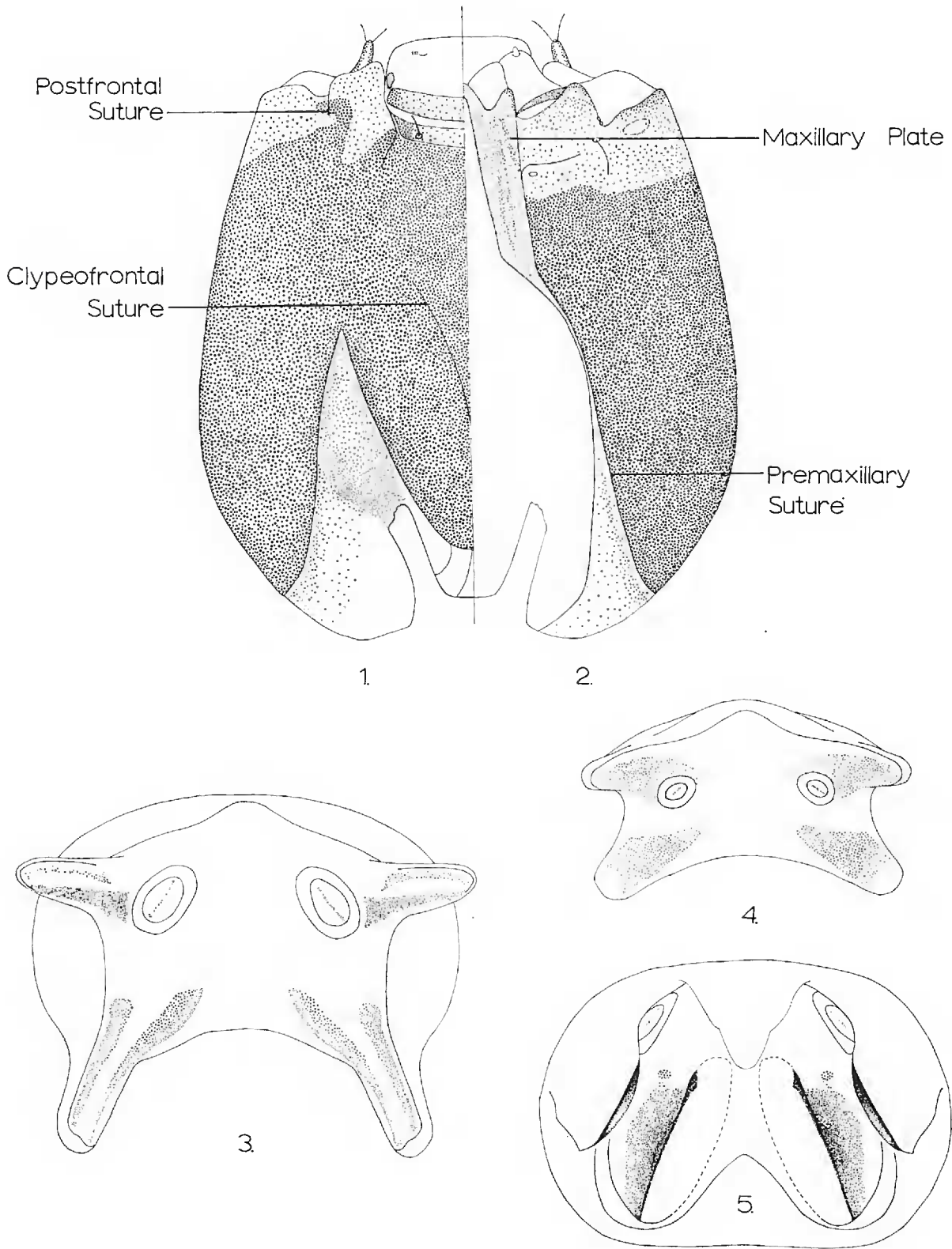
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the laboratory emerged during the months of August, September, and October in both cases.

Specimens of *L. sylvia* were obtained through the courtesy of Dr. R. D. Alexander, curator of insects, University of Michigan Museum of Zoology. All specimens collected personally by the author were fixed in hot Bouin's solution for twenty minutes and stored in 70% isopropanol. Sections of the head capsules were made according to methods described by Woodring and Cook (1962). Observations concerning the various structures and sutures were made from these sections as well as from whole mounts. Comparisons of the western forms are made with specimens of the eastern *L. sylvia*, and this information is included in the keys to the immature stages. The terminology used in the descriptions of the head capsule is basically that suggested by Cook (1949).

LIPSOTHRIX SHASTA Alexander

LAST INSTAR LARVA.—Length 22.0–31.0 mm; dextrosinistral and dorsoventral diameters both 1.1–1.6 mm. Body elongate, vermiform, terete except for the thorax and creeping welts. Thoracic segments of greater diameters and somewhat more flattened than remainder of body segments. Integument with gold-colored pile only slightly darker and longer around area of creeping welts. Creeping welts with microscopic hooks on dorsal and ventral surfaces of abdominal segments 2–7. Dorsal welts formed by three apparent zones, with the middle zone much darker than the anterior and posterior zones. Anterior and posterior zones scarcely different from the remainder of the segment. Combined length of segments 7–9 less than length of abdominal segment 5. Spiracular disk with four lobes, expanded, the dorsal lobe only slightly evident. No marking occurs on the dorsal lobe. The dorsolateral lobe with a very faint brown mark extending the length and width of the lobe to the base and around the upper margins of the spiracle. The ventrolateral lobes with slightly darker, but still very light, brown marking extending the length and width of the lobe. The setal fringe between the ventrolateral lobes similar to that of the remainder of the fringe surrounding the spiracular disk, approximately 0.048–0.064 mm long. The spiracular opening has no darkened spot occurring in the center of the spiracle. There are four anal gills present, subequal in length and width. Each anal lobe has three bulbous expansions appearing off the ventral margins (Fig. 13). These expansions become progressively smaller towards the outer tip, the lobe very slightly expanded before the tip. The head capsule (Figs. 1 and 2) is compact and massive. Length 1.36–1.39 mm (from the posterior margin of the maxillary segment to the anterior apices of the labrum): width 0.096–1.008 mm (at posterior mandibular articulation). Areas of the clypeus strongly sclerotized. The major portion of the ocular lobes strongly sclerotized but abruptly less so in area immediately surrounding the eye. The maxillary plate strongly sclerotized, anterior margin with three subequal teeth; posterior margin deeply cleft, the incision nearly dividing the central tooth. The remainder of the maxillary segment gradating to an unsclerotized state at the posterior apices. In the so-called incision area of the dorsolateral portion of the head capsule, there occurs a sclerotized triangular plate, incurved at the posterior margins, which



EXPLANATION OF FIGURES

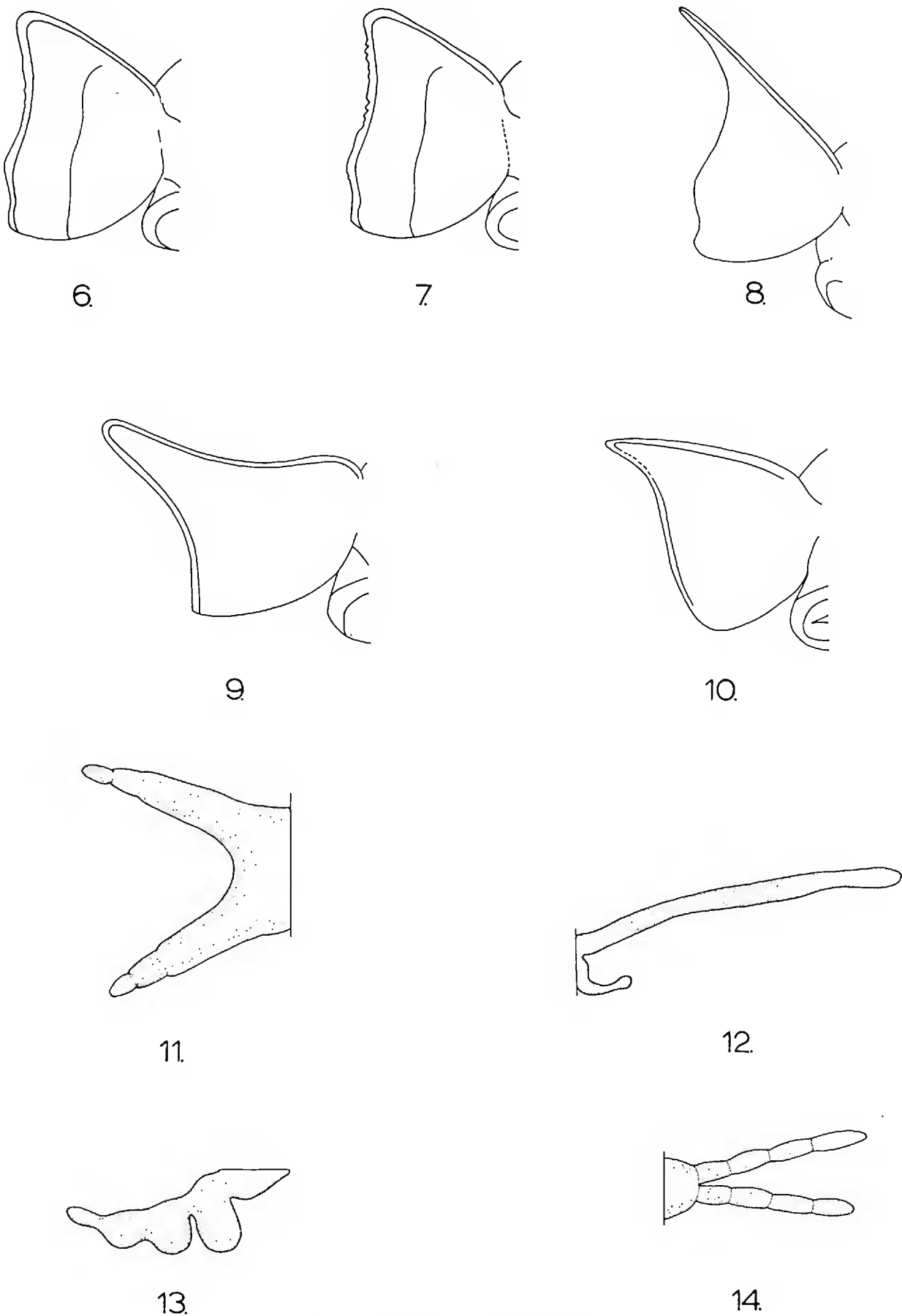
Figs. 1-2. *Lipsothrix shasta*, dorsal and ventral view of head capsule, respectively. Figs. 3-5. Spiracular disks of *L. hynesiana*, *L. nigrilinea*, and *L. fenderi*, respectively.

corresponds to the posterior border of the maxillary segment. The clypeo-frontal suture becomes obliterated at the extreme anterior limits. The postfrontal suture is not apparent superficially. The antennae are composed of a single segment, the basal portion very wide, the remainder cylindrical and heavily sclerotized, the apical papilla small with two elongate setae on either side. The antennae are inserted beneath small overhanging extensions of the antennal segment. The mandible is much the same as that described for *L. sylvia* by Rogers and Byers (1956). The anterior mandibular articulations are located laterad and below the antennal foramina. Whether or not this corresponds to the antennal buttress of other species is not clearly resolved. The posterior mandibular articulation is located slightly laterad of the maxillae. The articulations are so placed as to give the mandible a completely horizontal action. The labium retains the prementum which appears as a toothed plate. The hypopharynx is a relatively large, setulose lobe separated from the prementum by the opening of the salivary duct. The maxillae are deeply cleft as in *L. sylvia*, giving a biloped appearance, and bearing the one-segmented palpus. A small triangular cardo is present and articulates with the lateral portion of the structure called the maxillary plate. The suture occurring between the maxillary plate and the remainder of the ocular lobe is the premaxillary suture.

PUPA.—Length 15.0–16.0 mm; females somewhat longer than males; diameter at base of wing pads 1.44–1.63 mm. Form terete, gradually tapering from thorax to the cauda. Metathoracic breathing horns (Fig. 6) forming a cup or bowl with the diameter slightly greater than that of the thorax. There is no dorsocephalic extension of this cup; the basal half of the bowl is lighter in color and separated from the distal half by a dark ridge. A dark brown seam occurs adjacent to the frontal edges extending from the base to the ventrocephalic edge of the horn. The anterior portion of the thorax is dark brown, gradually becoming lighter at the posterior margins of the metathorax: abdomen dull white with cauda reddish brown. The posterior edges of wing pads end at junction of abdominal segments 2 and 3; apices of all tarsal sheaths are found at mid-length of abdominal segment 4; the antennal sheaths terminating beyond proximal ends of metathoracic femora and bases of wing pads, distance equal to about one-fifth the length of the antennal sheath. Wing pads and leg sheaths become blackish brown with age. Ventral creeping welts occur on segments 5–7; dorsal creeping welts on segments 5–7, with welts on segments 3 and 4 scarcely evident. Sternite of segment 8 with a single, pale brown, unarmed tubercle on posterior margin. On the dorsum of segments 8 and 9 occur five areas with fingerlike projections. The anterior of these areas is located on segment 8 and has two pencillike setae directed laterally and cephalad. The posterior areas on segment 8 have two lobes or fingerlike projections, with a very short seta on the medial projection and two pencillike setae on the lateral projection. On segment 9 are located two fingerlike projections, each with four pencillike setae. Cauda of the male has small, curved hooks directed dorsally and cephalad, a slight protrusion occurring at the base of each hook. The ventrolateral margins also with a sharp projection. Female with hooks much smaller and projection dorsally near apices of sheaths of tergal valves.

LIPSOTHRIX NIGRILINEA (Doane)

LAST INSTAR LARVA.—Length 21–31 mm; dextrosinistral and dorsoventral diameters the same, 1.3–1.6 mm. Integument with gold-colored pile, darker and longer around creeping welts. Dorsally, the anterior and posterior tufts surrounding the



EXPLANATION OF FIGURES

Figs. 6-10. Breathing horns of *L. shasta*, *L. nigrilinea*, *L. fenderi*, *L. hynesiana*, and *L. sylvia*, respectively. Figs. 11-14. Anal lobe structure of *L. hynesiana*, *L. fenderi*, *L. shasta*, *L. sylvia*, respectively.

welt area are much darker than the medial zone. Spiracular disk with lobes extended, the dorsal lobe scarcely evident with no markings. The dorsolateral lobes have brown marks extending the length and width of the lobes to the bases and around the upper margins of the spiracles. The ventrolateral lobes have slightly darker markings extending the width and length of the lobes. All markings generally much darker than those found in *L. shasta*. The setal fringe surrounding the spiracular disk generally longer (0.096–0.112 mm) and darker than that of *L. shasta*. Spiracular openings darkened, giving the appearance of a black spot in center of the spiracle (Fig. 4). Four anal gills present, subequal in length and width. Each lobe with three bulbous expansions appearing off ventral margins. These expansions becoming progressively smaller and only slightly expanded before the tip. Remainder of the details of the body form, spiracular disk, and head capsule similar to those given for *L. shasta*.

PUPA.—Length 12.0–14.0 mm. General body form and characteristics very similar to those of *L. shasta*, differing only in degree of sclerotization and generally much darker than that of *L. shasta*. Breathing horns (Fig. 7) cuplike with no extension of the dorsocephalic margin. The upper one-half to one-third of the anterior margin appears crenulate. These crenulations should not be confused with the extremely minute pits and occasional notches which appear in the same area on the pupal forms of the other species. The basal half of the cup light brown, outer half darker, separated by a dark brown ridge.

LIPSOTHRIX HYNESIANA Alexander

LAST INSTAR LARVA.—Length 22.0–30.0 mm; dextrosinistral and dorsoventral diameters 1.2–1.6 mm. Diameter of thoracic segments and creeping welts somewhat greater. Form elongate, vermiform, terete except for region of creeping welts. Integument with pile slightly yellow, creeping welts darker. There is no apparent division of the creeping welts into an anterior or posterior zone and no noticeable increase in the length or darkening of the setae surrounding the welt as a whole. The spiracular disk (Fig. 3) has four openly extended, elongate lobes, the dorsal lobe only slightly in evidence. The dorsal lobe has no markings. The dorsolateral lobes have brown markings that extend from the tip of the lobe to the spiracles. The basal portion of the markings darker than the distal area. The lateroventral lobe has a brownish stripe extending from the median area. There are four anal lobes (Fig. 11), elongate, subequal in size with no apparent bulbous enlargements. The head capsule and remaining body form very similar to that described for *L. shasta*.

PUPA.—Length 13.5–14.0 mm; dextrosinistral diameter at base of wing pad 1.1–1.6 mm; dorsoventral diameter 0.1 mm less than the dextrosinistral diameter of each specimen observed. General body form similar to that of *L. shasta*. Breathing horns (Fig. 9) cuplike with dorsocephalic margin extended forward as in *L. fenderi*. The extended tip of breathing horn not so thin as in *L. fenderi*. The entire margin of the breathing horn with a dark rim. The male and female cauda similar to that described for *L. shasta*.

LIPSOTHRIX FENDERI Alexander

LAST INSTAR LARVA.—Length 16.0–30.0 mm; dextrosinistral and dorsoventral diameters both 0.63–0.96 mm, the thoracic segments and creeping welts somewhat greater. General body form similar to that of *L. sylvia* and extremely delicate.

The spiracular disk has five lobes folded back on each other so as to form a terminal cone and concealing the inner surface and markings of the lobes (Fig. 5). This closely parallels the description for *L. sylvia*, but *fenderi* does possess a definite dorsal lobe marked with an unbroken, thin, dark brown stripe from the tip to the base of the lobe. The dorsolateral lobes marked faintly at the tip, becoming darker mid-length and again fading to light brown at the spiracles. The ventrolateral lobes marked with uneven stripes, darker brown at the junction of the stripes and a small abruptly dark spot occurring at the base of the lateral stripe. The margins of each lobe bear a row of slender, pale setae, appearing as a tuft at the tips of the lobes. Creeping welts seen only under higher magnifications and show no apparent darkening of the area. There are four slender anal lobes (Fig. 12) with the anterior pair nearly five to six times longer than the very short posterior pair. There are no expansions as in the case of *L. shasta*. The head capsule differs in structure from that of the other species only in that a short, but definite, tooth appears on each side of the three larger ones giving the maxillary plate the appearance of having five teeth. Corresponding lateral teeth are only faintly observed in all the other species. The clypeal area from the region of the clypeo-labral suture to about mid-length of the clypeus is less sclerotized than the surrounding area.

PUPA.—Length 11.0–14.0 mm; females slightly longer than males. Dextrosinistral diameter at base of wing pad 1.4 mm; dorsoventral diameter at base of wing pad 1.1–1.2 mm. General coloration of the body pale white, body form similar to that of *L. sylvia* but, unlike the latter species, *L. fenderi* has very little darkening of the wing pads or leg sheaths as the pupa matures. Breathing horns (Fig. 8) cuplike at base, with the dorsocephalic margins extending forward and beyond the basal cup into thin, delicate points. The dorsal margin of the breathing horn is seamed with dark brown from the base of the horn to its tip. Two short setae occur on the tips of the curved hooks on the cauda of the male. Other details of the male and female cauda similar to those described for *L. shasta* or *L. sylvia*.

The characters used in the following keys to the immature stages can be applied to either living or preserved specimens. Although the fourth instars were used for the larval keys, the characters used for description will apply for all instars except the first, which appears to be different in structure from those of the later instars.

KEY TO THE LARVAL FORMS OF THE GENUS LIPSOTHRIX IN
NORTH AMERICA

- 1. Spiracular disk with lobes expanded; inner surfaces and markings clearly seen 2
- Spiracular disk with lobes forming a terminal cone; inner surfaces and markings not clearly seen 4
- 2. Anal lobes with elliptical, bulbous expansions 3
- Anal lobes with no bulbous expansions *L. hynesiana*
- 3. Spiracle with a darkened, central area *L. nigrilineo*
- Spiracle without a darkened central area *L. shasta*
- 4. Anal lobes subequal in size and shape (Fig. 14) *L. sylvia*
- Anal lobes with anterior pair five to six times longer than posterior set *L. fenderi*

KEY TO THE PUPAL FORMS OF THE GENUS *LIPSOTHRIX* IN
NORTH AMERICA

1. Breathing horns cuplike, with dorsocephalic edge of each horn extending forward 3
Breathing horns with no such extension as described above 2
2. Anterior edge of breathing horns crenulate; apices of the leg sheaths mid-length of abdominal segment four *L. nigrilinea*
Anterior edge of breathing horns not crenulate; apices of leg sheaths at posterior margin of abdominal segment four *L. shasta*
3. Dark seam extending from dorsal base to forward extension of breathing horn *L. fenderi*
Dark seam extending from dorsal base past forward extension to the ventrocephalic margin of the breathing horn 4
4. Dorsocephalic extension pointed or acute (Fig. 10) *L. sylvia*
Dorsocephalic extension rounded *L. hynesiana*

From the data presented in this paper, certain affinities appear among the species described. Study of the morphological patterns in the larval and pupal structures indicates the formation of two species groups within the generic limits as now defined. One group, composed of *L. shasta* and *L. nigrilinea*, is very closely allied in all structures studied. The eastern *L. sylvia* and the western *L. fenderi* are also closely allied in details of body structure of the larval and pupal forms and compose the second group. The affinities of *L. hynesiana* to either group are still in question. The larval characteristics of this species indicate relationship to the *shasta-nigrilinea* group. In the pupal forms, however, the structure of the breathing horns is more like that of the *fenderi-sylvia* group. The adult characteristics also show a greater affinity with those of *L. fenderi* than to those of the other American species (Alexander, 1964). In view of these data, *L. hynesiana* must, at present, be considered as belonging to the *fenderi-sylvia* group.

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